Volume 22 July, 1936 *Number 7*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

The Relation of Cost to Economy

Deep Well Pump Lubrication

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LUBRICATION

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Published by

The Texas Company, 135 East 42nd Street, New York City

Vol. XXII | July, 1936 | No. 7

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The Relation of Cost to Economy

FIRST cost with respect to ultimate economy in plant lubrication is frequently clouded by incidental details which should have no bearing on the question. Normally it begins with the cost per pound or per gallon, according to the nature of the lubricant. From the viewpoint of purchasing efficiency it is extremely advantageous to follow such a course. At the end of each fiscal year, if unit costs of materials and supplies can be successively reduced, obviously the purchasing policies are being judiciously directed.

Unfortunately, however, the unit cost idea, as applied to initial expense for lubricants, does not always lead to ultimately the lowest cost for lubrication. Many variables may be present which must be considered. These will have to do with operating conditions in the plant, means and methods by which lubricants are handled and applied, and the relative cost of the amount of lubricants needed with respect to the work required.

This will apply primarily to production machinery, although it can very easily be extended to the production line where unit pieces of equipment, such as electric refrigerators, motors or power transmission devices must be lubricated for service during the process of manufacture.

The cost of lubrication rather than the cost of lubricants should therefore be given primary consideration. Those who have studied these details in power and industrial plant operation fully realize that there is more to the cost of lubrication than just the initial cost of the necessary lubricants, their means of application and the labor required.

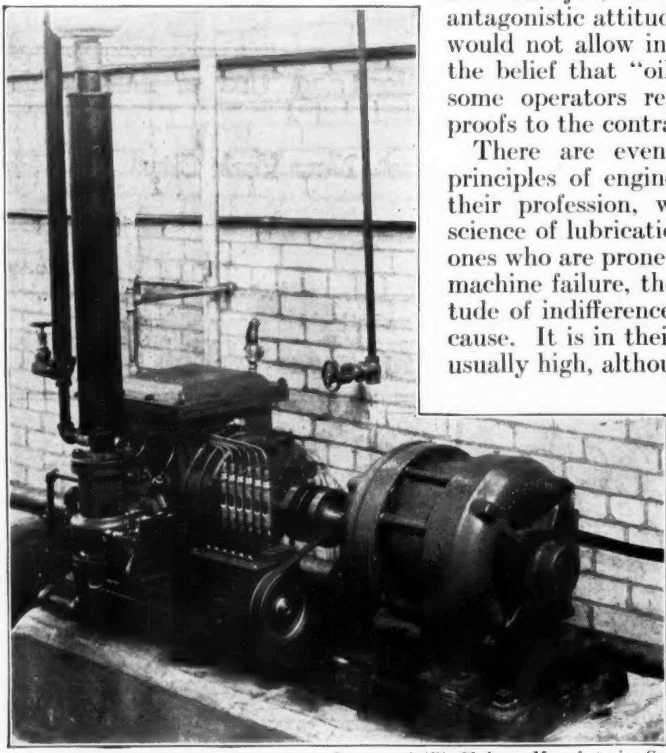
Excessive maintenance and repair expense due to thoughtless selection of improper lubricants, faulty lubricating equipment, or negligence must justly be regarded likewise as a cost chargeable to the lubricating account. In consequence, a study of the means and methods of bringing about reductions in maintenance and repair must be given serious consideration. Initial cost of lubricants, lubricating equipment and the labor involved in application will be relatively stable. But the cost of upkeep in the maintenance of bearings, gears and chains, etc., in proper condition to function efficiently may vary widely. Effective lubrication is insurance in this regard, it is the secret of minimum friction, reductions in wear and dependable operation of machinery as a whole.

Lubrication is furthermore a most decided factor in the maintenance of production schedules. Production will naturally depend to a great extent upon keeping machinery running. There is no more prevalent cause for cessation of operation than imperfect or insufficient lubrication. As a result, in view of the fact that the management is responsible for production, naturally their interest should be centered quite as keenly upon this most important adjunct to operation. There was a time when lubrication simply required the application of lubricants; also the greater the volume used the more effectively did we believe the plant was running. Today, however, this idea has been disproved. Conservation of lubricants, and decrease in costs of maintenance and labor must be considered.

In this way the science of lubrication came into existence, and the study of lubricating

problems became as equally important as the study of power economy.

Lubrication is directly related to the cost of maintenance and repair, for if lubrication is not carried out by products suited to the operating conditions maintenance cannot be dependably controlled. In other words, regardless of how efficient a lubricating system may be, if the lubricant is not suited for the purpose, or if it has been stored and handled in a sloppy manner and allowed to become contaminated with dirt or other foreign matter, there will always be danger of wear, overheating of bearings or faulty circulation, which will lead ultimately to failure of some part of the machine. This is when repair bills become abnormal and disruption of the production schedule occurs.



Courtesy of Allis-Chalmers Manufacturing Co.

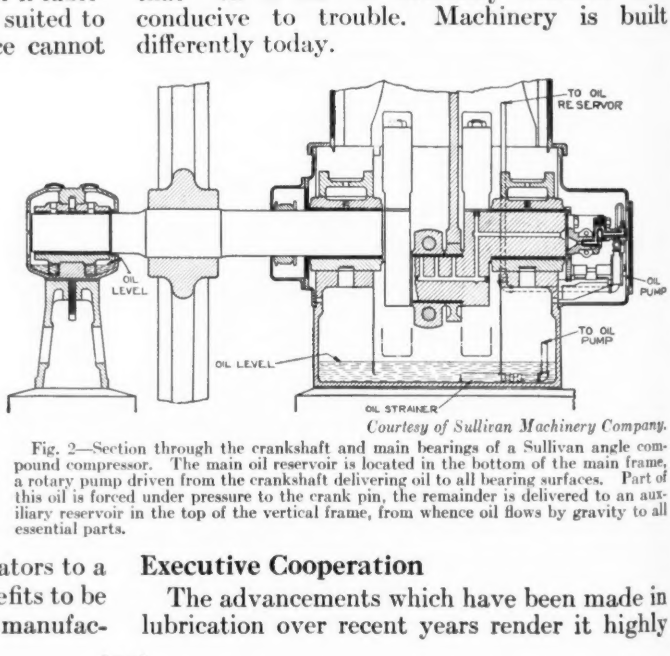
Fig. 1—Showing an Allis-Chalmers "Ro-Twin" compressor. Note suction air filter, silencer, automatic unloader, and especially the means for automatic lubrication. Every provision has been made in this installation to render lubrication automatic and dependable.

How Research and Publicity Have Helped

To bring plant executives and operators to a realization of the advantages and benefits to be derived from effective lubrication, manufacturers of lubricants and builders of lubricating equipment have expended huge sums in extensive research and educational and publicity campaigns. In many fields it has been a difficult job, for they have had to overcome a definitely antagonistic attitude, even to the extent that some plants would not allow inspection of their equipment. In fact, the belief that "oil is oil" still prevails in the minds of some operators regardless of practical and theoretical proofs to the contrary.

There are even purchasing agents, trained in the principles of engineering and regarded as authorities in their profession, who will state point blank that the science of lubrication is relatively "bunk." They are the ones who are prone to blame the lubricant in event of any machine failure, though they will maintain a stolid attitude of indifference as to WHY it should have been the cause. It is in their plants that the cost of lubrication is usually high, although the cost for lubricants may be low.

So, when one states that there is a lubricant for every purpose it is not merely advertising; it truly means what it says and is backed by years of research and millions expended. As a result, it is folly for the skeptic to maintain an attitude of seeming indifference. He would not ignore the development of new types of machinery adapted to his plant operations, so why should he ignore the vital factor that keeps them running. He need only try a heavy gear oil or a cheap grade of red engine oil on the bearings of a high speed turbine, or on the spindles of a textile machine, to quickly discover that the idea that "oil is oil" is decidedly obsolete and conducive to trouble. Machinery is built differently today.



Courtesy of Sullivan Machinery Company.

Fig. 2—Section through the crankshaft and main bearings of a Sullivan angle compound compressor. The main oil reservoir is located in the bottom of the main frame, a rotary pump driven from the crankshaft delivering oil to all bearing surfaces. Part of this oil is forced under pressure to the crank pin, the remainder is delivered to an auxiliary reservoir in the top of the vertical frame, from whence oil flows by gravity to all essential parts.

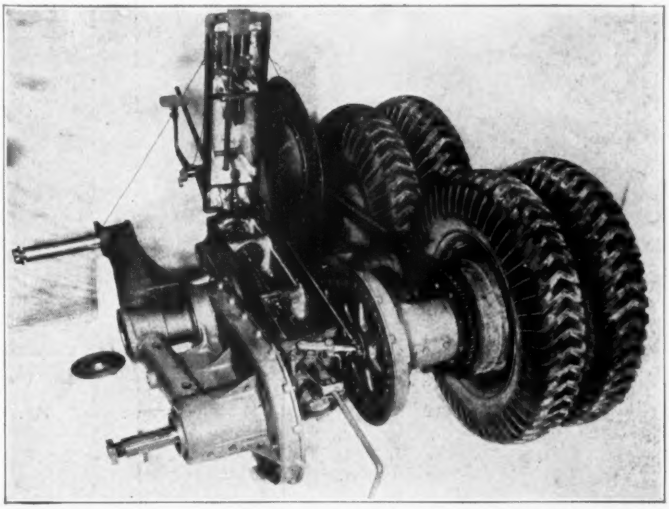
Executive Cooperation

The advancements which have been made in lubrication over recent years render it highly

advisable for the industrial and power plant executive to keep pace with this progress, just as the lubricating engineer has kept pace with industrial and machine development. This will lead to maximum production with minimum operating costs. Furthermore, the executive must realize that it is scientific research, not advertising propaganda, which dictates that there is usually a grade of lubricant best suited for each and every type of operation, as indicated by its physical characteristics and chemical stability.

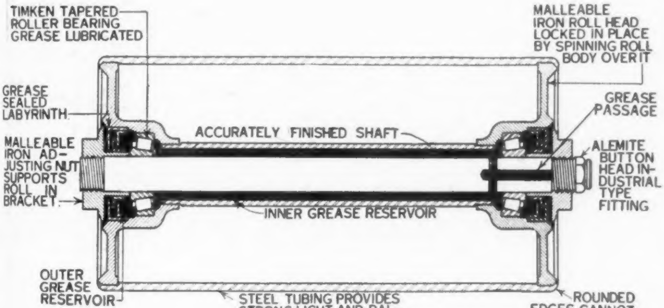
This ultimate maximum of efficiency in the usage of lubricants, however, is only attainable through continuous cooperation between plant executives and engineers, and the lubricating experts representing the oil industry. For this reason it is advisable, where the volume of lubricants concerned will warrant, to employ a lubricating engineer whose duties should be the supervision of plant lubrication. He should preferably be a technical man, familiar with machine details and lubricating equipment, conversant with the usual grades of lubricants on the market, and able to plan and carry out practical experimental work to prove the adaptability of such products with respect to his operating conditions.

In cooperation, the petroleum industry is devoting intensive research relative to the development of lubricants which will be adapted in every characteristic for the service they are intended to perform. Naturally a wide range of conditions must be taken into consideration in this work due to the fact that many plants will operate similar machines quite differently, and grades of lubricants that would be suitable to one fail in another, due essentially to such elements as excessive heat, water, acids or other chemicals. It is a broad subject, but one wherein cooperation will solve many of the minor problems, and so govern matters that the seriousness of the larger problems will be reduced to a marked degree, with decidedly favorable reaction upon the cost of lubrication irrespective of the initial cost of the lubricants employed.



Courtesy of The Austin-Western Road Machinery Co.

Fig. 3—Close-up view of a 6-speed transmission for an Austin-Western motor grader. The variety of operating mechanisms essential to this device are plainly shown.



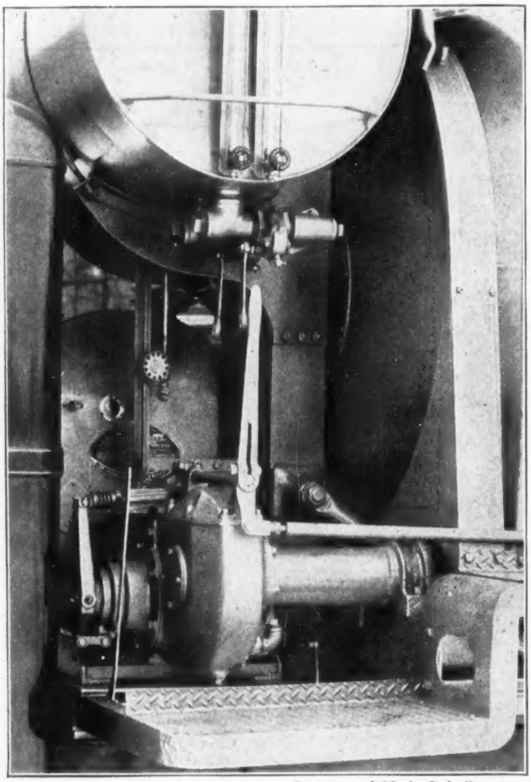
Courtesy of Link-Belt Company.

Fig. 4—Details of the Link-Belt Type "70" anti-friction belt conveyor idler. A device of this nature must be very carefully designed for protected lubrication due to the abrasive or moist nature of the materials which must be so often handled. Note the type of sealing employed to prevent contamination of grease by such foreign matter.

Many of these problems are largely dependent upon the care with which the lubricants are originally selected and the intelligence of the operators who have to do with their storage, handling and application. The amount of care which must be given to selection of lubricants will, of course, depend in turn upon the reliability of their source. If bought from a refiner of recognized integrity, furnishing engineering service and technical advice to its customers, the possibility of its products becoming involved in difficulties will be far less than where lubricants are bought by the users according to their own ideas. Hence the value of lubricating engineering service, the purpose of which is to increase machine efficiency and production to a maximum by the elimination of lubrication problems wherever possible, and develop the most economical cost of lubrication. Obviously, this is intimately related to cost of upkeep and maintenance.

MACHINE DESIGN

The general procedure of providing for lubrication has undergone marked change during recent years, with more attention being given continually towards designing for adequate and accessible lubrication when machinery is in the development stage. In the end this is a most economical procedure for it enables concealment of oil circulation piping, handy location of grease fittings, and other features which will reduce the possibility of damage to lubricating equipment. In other words, effective lubrication of any type of mechanism may be said to begin in the drafting room, with the design of the parts involved and consideration of the method by which lubrication is to be accomplished.



Courtesy of Chain Belt Company.

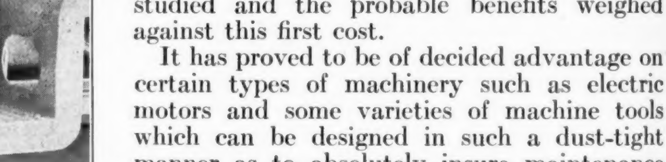
Fig. 5—Showing part of the power plant of a Rex Moto-Mixer. Here again, in the handling of concrete products, protection of all moving parts against contamination of lubricants is highly essential.

In the past there has been altogether too much tendency to regard lubrication as an after-thought, moving elements being designed with respect to their duty and the function to be performed. Inadequate capacity of oil reservoirs, or improper location of points of lubricant application are tangible evidence of the fallacy of this procedure. The modern machine designer, however, places the true value upon lubrication, to the extent that automatic lubrication is coming to be rightfully accepted as a necessity, particularly where intricate mechanisms are involved. Failure, due to abnormal wear, obviously would entail considerable expense, loss of time, or interruption of production schedules. This latter is especially important to remember in the automotive industry, and in the manufacture of paper, for example, where machinery operations are inter-related and where production is carried out on a wide variety of machinery with coordinated functions.

Sometimes it is impossible, however, to prevent a machine from coming in contact with abrasive foreign matter. Under such conditions the designer may be justified in giving it less consideration than he would a device which can be installed apart from dust or dirt and the detrimental effects of water or widely varying temperature conditions. This should never be done, on the other hand, until cost of housing, seals, or other means of protection have been studied and the probable benefits weighed against this first cost.

It has proved to be of decided advantage on certain types of machinery such as electric motors and some varieties of machine tools which can be designed in such a dust-tight manner as to absolutely insure maintenance of effective lubrication under exposure to most exacting operating conditions.

In turn, this has been materially aided by the development of the anti-friction bearing and the success achieved by the builders of such bearings in construction of dust guards



Courtesy of Ingersoll-Rand Company

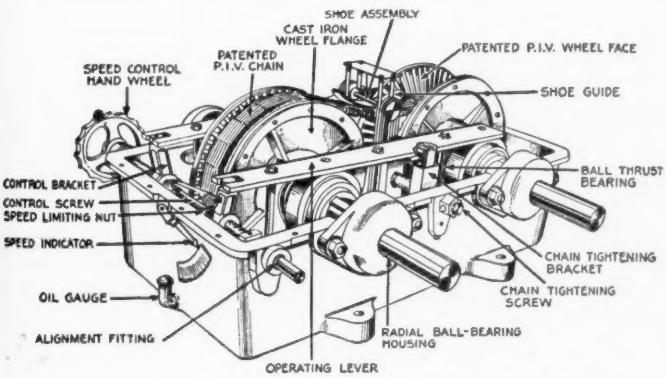
Fig. 6—An installation of oil-engine-driven Cameron pumps through step-up gears, designed for oil pipe line service. Distinctive lubricating requirements of the parts involved call for the utmost care in segregation of lubricants during their storage to prevent any possibility of mis-usage or mixture.

and means of lubricant retention in the form of labyrinth, leather or grease seals. The splash-proof motor is one of the most noteworthy examples of protected design.

Lubricant Refinement Contingent Upon Design

Design must, therefore, be given consideration in deciding upon the degree of refinement essential in a lubricant. Wherever the design of bearings, gears, chains or other moving parts is such that they must function comparatively exposed, if it is impracticable to prevent drip or waste, a cheaper grade of lubricant can normally be recommended than where such conditions do not exist. In other words, there is a relationship between design and lubricant refinement.

An ordinary grade of lubricant may not possess the same lubricating ability as a more highly refined product; on the other hand, the use of the latter under such conditions would not be economical nor an assurance of any better lubrication, due to the fact that it might become unduly contaminated, with consequent reduction in its original lubricating ability. Furthermore, an initial high cost would not be justified where drip or premature waste cannot be prevented. Correction of structural conditions is the logical procedure if this is to be overcome. A condition involving waste

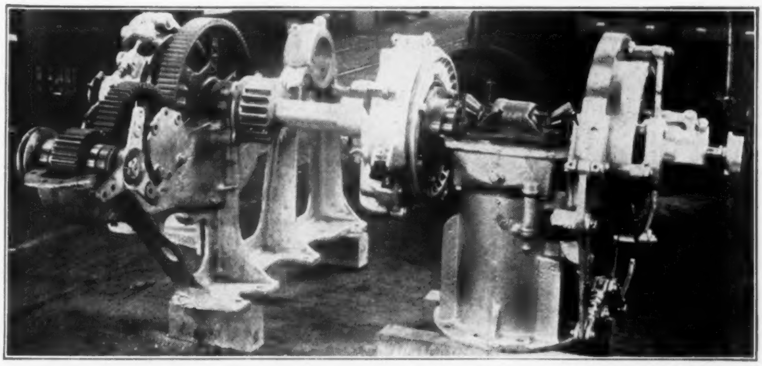


Courtesy of Link-Belt Company.

Fig. 8—Details of a Link-Belt P.I.V. speed reducing assembly, showing types of bearings employed and means for lubrication.

should never be accepted as inevitable. Every endeavor should be made to correct it if it can be accomplished without abnormal expense. This will be especially true under conditions which may cause contamination of lubricants during service, for the attendant possibility of damage or abrasion of moving parts must not be overlooked.

Waste can be prevented in many ways, de-



Courtesy of Bucyrus-Erie Company.

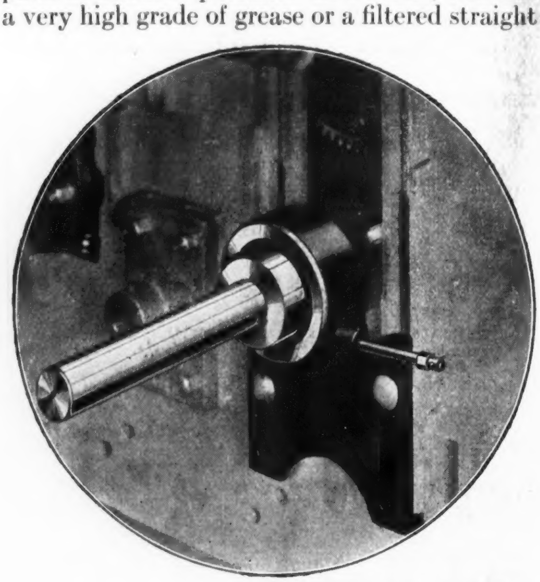
Fig. 7—Showing the type of gear assembly essential to the Bucyrus-Erie shovel-dragline-crane. All these gears in operation are enclosed in oil-tight casings to prevent leakage of lubricant and entry of contaminating foreign matter.

pendent upon the design of the equipment, the product being handled, the duty involved and the location. Frequently slight changes in design may solve the problem. In the steel mill, for example, especially on certain older types of equipment, gears and bearings are sometimes but inadequately protected from the scale, dust, dirt and sometimes water which may come in contact with such moving parts.

It is practicable, of course, to enclose gears in sheet metal housings, and to install bearing guards which will materially reduce the extent to which lubricants may be contaminated. By this prevention of contamination the durability and life of such products can be extended with marked results in economy. Sometimes, however, the first cost will be given too much consideration; this is an error, it should be regarded as insurance against parts replacement and loss of production time.

It will always be beneficial for the lubricating engineer to study design from this point of view. He may, however, not always be able to prevail on his accounts to spend the money for such means of protection. It is then his duty to decide upon grades of lubricants commensurate with the existing operating conditions. It is, therefore, more or less of an ideal to prepare a theoretical lubrication recommendation for any specific type of machine without complete knowledge of the operating conditions. Normally it would have to be based upon modern design and the assumption that the builders have realized the importance of lubrication

and the necessity for protecting the moving parts as much as possible. As a result, whereas a very high grade of grease or a filtered straight



Courtesy of Saco-Lowell Shops.

Fig. 9—Gear end bearing unit of a Saco-Lowell spinning frame equipped with the Fafnir type ball bearing. Note provision for grease lubrication and compact nature of the entire housing.

mineral oil might be adaptable to such a type of design, in the case of an older installation it might be necessary to substitute an entirely different type of lubricant to meet the existing constructional conditions, and the nature of the operations.

A working lubrication recommendation should, therefore, include two or more grades of lubricants of varying degree of refinement; where oils are involved, however, they should be of approximately the same viscosity, commensurate with the speed, operating pressure, and the extent to which temperature variation may occur. The operator should, in turn, realize this when in the market for such lubricants. If he is dealing with a representative of a reputable oil company these facts will be brought to his attention, the proper viscosity or body of the lubricant decided upon, and the choice between a primary and secondary grade of lubricant justified according to the location of the installation, the possibility of contamination and the extent to which unavoidable loss through waste may occur.

HOW LUBRICATION AFFECTS MAINTENANCE

The necessity for maintenance as it may involve parts replacement is directly related to lubrication, for it is the result of wear, attributable in many cases to the use of unsuitable lubricants, or contamination in service. It is not always practicable to obtain the most suitable product for a job; furthermore, limitation of the means for handling might prevent its most effective application. Likewise, contamination may sometimes be beyond the control of the operator. One must never forget, however, the subsequent price he may have to pay in the form of increased maintenance and repair costs. For this reason the mechanical condition of machinery with respect to wear of moving parts and development of more or less misalignment may often make it advisable to consider specialized lubrication quite foreign to the type of lubrication originally provided for by the designer. This will often arise where maintenance has been neglected or where a grade of lubricant has been used which is unsuited to the means of application or the operating speeds, temperature, or load.

The past few years of restricted income have led far too many to study first cost as applied to lubricants and completely overlook the ultimate potential effect on machine production and cost of maintenance. It is obvious

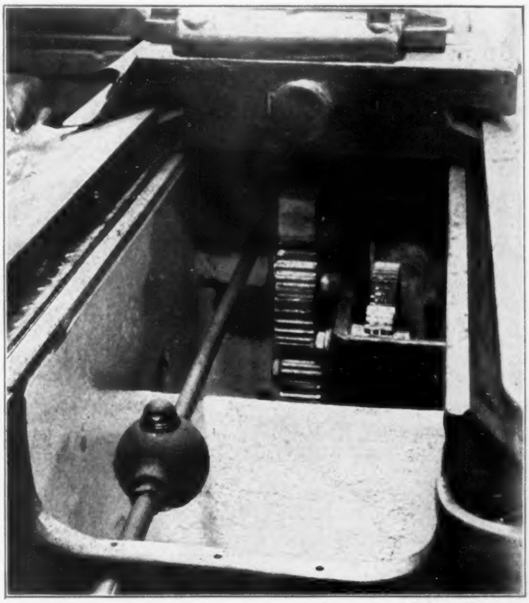
Courtesy of Hills-McCanna Company.

Fig. 10—An 8-feed Hills-McCanna lubricator serving the drilling chains on a draw works. The advantages of using this means of lubrication from the viewpoint of cleanliness is quite obvious. In addition, lubricating oil is protected against the possibility of contamination.

that such a procedure is false economy. It is, furthermore, a disturbing factor to the lubricating engineer in servicing such equipment,

for it necessitates consideration of lubricants which normally should not be suggested, due to properties which might lead to abnormal internal friction and power consumption. Sooner or later this will lead to wear, misalignment and increased clearances. In some types of mechanisms this will be relatively unimportant. Wherever accurate process work must be produced, however, or where pressures must be maintained as in the reciprocating engine or compressor, increase in clearance between bearings and shafting, between piston rings and cylinder walls, or alteration of the pitch line of a gear set, may seriously affect the productive efficiency of the entire machine, the power output, or the accuracy of the work.

In the operation of certain types of gears and roller bearings, misalignment and uneven wear may often cause marked increase in unit bearing pressures, thereby necessitating the use of a lubricant capable of forming a protective film of unusual strength. Provided the design is such as to enable retention of this lubricant at the point of maximum load, there will be a certain amount of added insurance that wear and clearance increase will be retarded. Unfortunately, however, where misalignment of either gears or bearings has occurred, it is very possible that leakage of lubricant will result and reduction of pressure on the film itself cannot be maintained. Under such conditions it is obvious that the expected benefits of extra-film strength may not be fully realized, in view of the inability of the lubricant to remain for a sufficient length of time between the contact parts. So the use of such a product, often at



Courtesy of Norton Company.

Fig. 11—Showing a Norton surface grinding machine designed for hydraulic operation and automatic lubrication. The base of this unit serves as the oil reservoir, with all parts so located that in event of leakage oil will drip back into the reservoir. By reason of the pressure under which the oil is handled, a comparatively light viscosity, straight mineral lubricant functions most effectively on this unit.

a considerable increase in price above the cost of the normally accepted type of lubricant, becomes but a temporary remedy instead of a permanent cure.

Courtesy of Trabon Engineering Corporation.

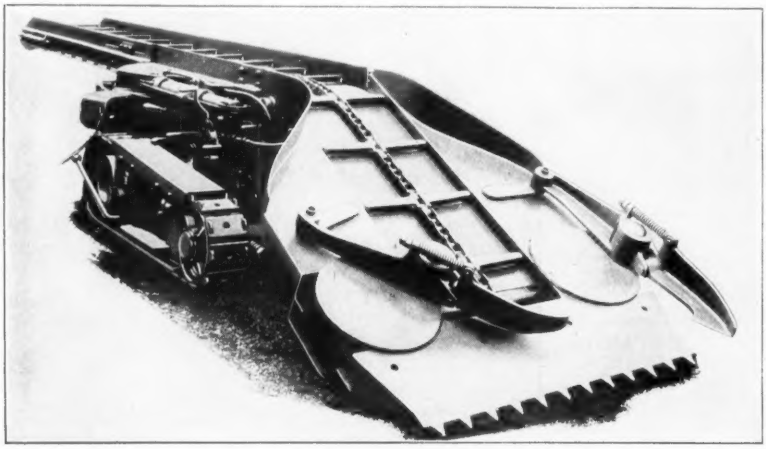
Fig. 12—Showing how the Trabon centralized system of lubrication can be applied to the operating mechanism of a power shovel. This is a type of operation wherein protection of lubrication is highly essential.

In the rehabilitation of machinery, it is, therefore, highly essential to remember that by adopting a repair program which will correct mechanical defects detrimental to effective lubrication, the economical use of lubricants can be more easily accomplished and more permanently maintained. Many improvements in bearing design, power transmission equipment, and methods of lubrication have been made over the past few years. In addition, research in the petroleum industry has proved the practicability of manufacturing both lubricating oils and greases to more nearly meet the mechanical requirements of machine design. Correlation of these improvements to the benefit of plant production

schedules, and reduction in cost of maintenance, should appeal to every plant executive.

PLANT INSPECTION

Inspection is an important part of the lubrication procedure in any plant. It is especially beneficial where new installations are being run in and where accurate regulation of lubricating equipment may be conducive to economy.



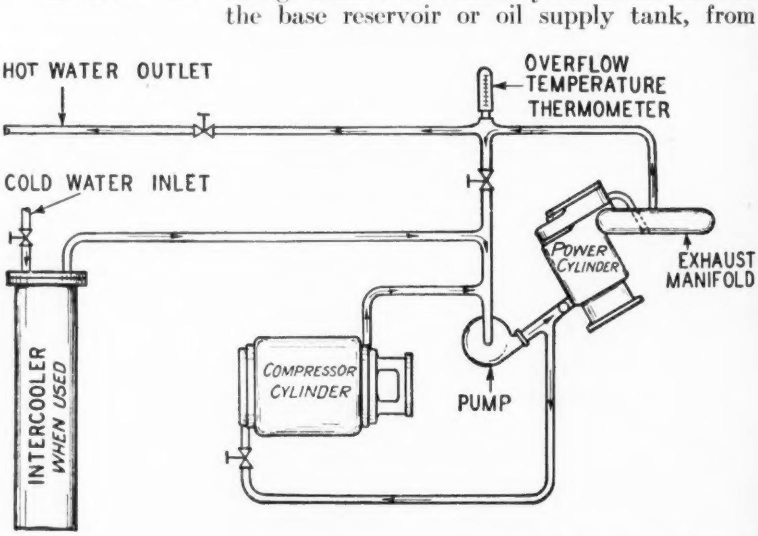
Courtesy of Joy Manufacturing Company.

Fig. 13—Typical view of a Joy 8-BU type coal loader. Note the relative location of the coal gathering arms with respect to the conveyor and tractive elements.

Inspection of heavy machinery or equipment pertinent to an entire production process should be made with the full cooperation of the installation engineer of the machinery builder. The routine to follow requires consideration of alignment, bearing clearances, means of sealing to prevent entry of water or non-lubricating foreign matter, the adaptability of the lubricating equipment to the operating requirements, and the location and accessibility of the latter.

Assurance that the lubricating system can be depended upon positively to deliver the required amount of oil or grease to the moving parts of the machinery in question is absolutely essential. In making primary inspection this should never be overlooked, for no matter how perfect the bearings, piston ring fit or sealing devices, if there is any possibility of impaired flow or distribution of lubricant, serious wear may develop to cause disruption of production schedules and require costly repair.

Where force-feed circulating oiling systems are involved, such an inspection will be particularly advantageous, for initial operation will always tend to lead to the accumulation of a certain amount of non-lubricating, foreign matter, just as holds true in the automotive engine when it is new. Such foreign matter may be composed of core sand, or fine metallic particles developed during the wearing-in period. If oil is circulated in sufficient volume under adequate pressure, or if grease is periodically delivered under comparatively high pressure, there will be but little tendency for such foreign matter to accumulate within bearing clearances or oil grooves. Where grease is employed, such materials will, in all probability be forced out through the ends of the bearings. In the average oiling system, however, such foreign matter will normally be carried back to the base reservoir or oil supply tank, from which it can be removed at the cleaning period.



Courtesy of Ingersoll-Rand Company.

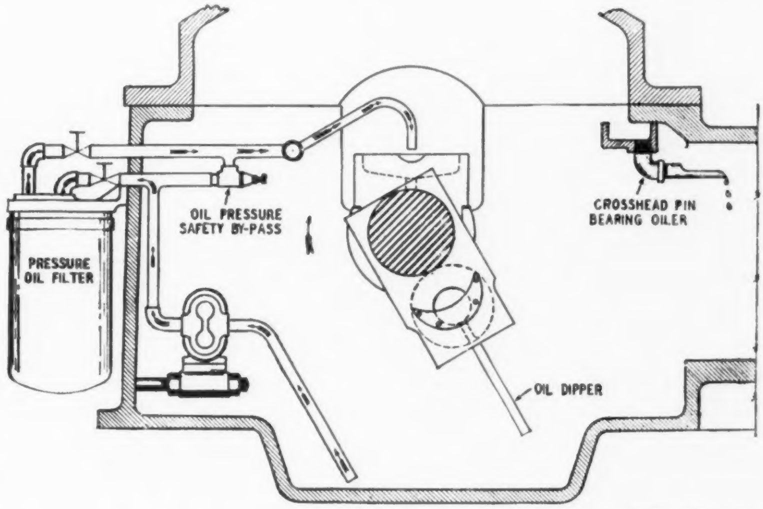
Fig. 14—The lubrication system of the power unit of the Ingersoll-Rand gas-engine-driven air and gas compressor. In this unit all bearings are continuously flooded with a large volume of oil which is kept clean by a suitable type of filter. Oil circulation from the crankcase through the various bearings is maintained by a gear pump. Pistons, piston pins and crossheads are all lubricated by oil thrown off the crankpins and by direct splash from the dippers on the crank.

At the same time bearings should be checked for misalignment. The possible entry of water should also be carefully checked. It is important to remember that water, along with metallic particles, may lead to development of sludge

formation. This is decidedly objectionable in steam turbine operation. On the other hand it should not be allowed to occur anywhere else if it can be prevented, for it is the forerunner of impaired lubrication and clogging of the lubricating system.

The time required to make a primary inspection will, of course, depend upon the type of machine in question. The paper machine is a good example. Here a wide variety of bearings are employed, water and paper pulp are present, also comparatively high temperatures on the drier end of the machine. In this machine, alignment is one of the most important factors pertinent to continued and satisfactory operation. Bearing wear, particularly where plain bearings are involved, should, therefore, be studied with the utmost care. In contrast, a steam pump or reduction gear set would entail only inspection of the cylinder walls or gear teeth to make sure that the proper amount of lubricant is being delivered to prevent scoring, scuffing or abnormal wear.

The value of primary inspection has been evidenced in connection with a recent Diesel engine installation, following the development of abnormal oil consumption after renewal of piston rings. Cursory examination of the crankcase gave no indication of abnormal vaporization, nor was there any evidence of inadequate lubrication, or formation of serious carbon deposits. With the realization that installation of new piston rings might give rise to a certain amount of leakage until they are worn to a running fit, the surface of the rings was studied, to observe whether they might be installed upside down, with the sharp edge tending to scrape oil up into the combustion chamber.



Courtesy of Ingersoll-Rand Company.

Fig. 15—Details of the cooling system of the Ingersoll-Rand gas-engine-driven V-type air and gas compressor. By use of this unique design, temperature differences are eliminated to the interest of improved lubrication.

With this thought in view, the rings were reversed. The results were extremely gratifying. Immediately after the engine was put back into service the oil consumption dropped materially.

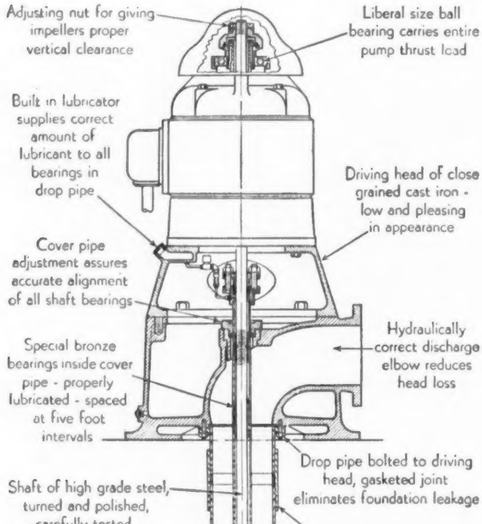
As a general rule it is impracticable entirely to tear down a piece of machinery to make such an inspection. Where time and cost will permit, however, it would normally be advantageous, in view of the extent to which future trouble might be prevented and the life of the machine increased.

Deep Well Pump Lubrication

The lubrication of deep well centrifugal pumping machinery is a problem in the irrigation and water works field, where water must be raised from considerable depth. For this purpose vertical centrifugal pumps are often used. Water is usually brought to the surface through a pipe within which the pump shaft is located. This shaft carries one or more impellers, according to the depth involved, the amount of water to be pumped, and the size of the well casing. It is the function of these impellers to raise the water at the requisite rate of discharge. Rotation is usually brought about by means of electric motor power. Due to the speeds of operation, which may range from perhaps 700 to 3600 R.P.M., direct drive is possible, although belt connections are perfectly feasible and frequently more practical.

One of the essential lubricating problems on such pumps is to take care of the steady bearings in the cover pipe. These latter serve to center and hold the shaft in proper alignment, prevent deflection and maintain the requisite pressures with as vibrationless operation as possible. But only can these ideals be attained through the medium of effective lubrication. Essentially, the lubricant should be so constituted that it will (1) maintain the requisite

lubricating film; (2) have as little tendency as possible to run out at the bottom of the pump from between the shaft and casing or cover pipe; and (3) show as little internal friction as



Courtesy of Worthington Pump & Machinery Corp.

Fig. 16—Typical section of a Worthington Type Q deep well turbine pump. Note built-in lubricator at upper left below the driving motor which supplies the right amount of lubricant to all bearings in the drop pipe. Other details of lubrication are also plainly indicated.

possible, for otherwise this would act as a brake on the impeller shaft.

Water can of course be used as a lubricant on such pumps, especially where a cover pipe is not employed. It is effective, economical and prevents the possibility of contamination of the water being pumped. Under certain conditions of sand, or the presence of other such fine particles of foreign matter in suspension, it is, however, generally considered better practice to provide for oil lubrication, installing a suitable cover pipe and bearings of design capable of bringing this about. Where water is the lubricant, these latter are oftentimes of rubber or hard wood.

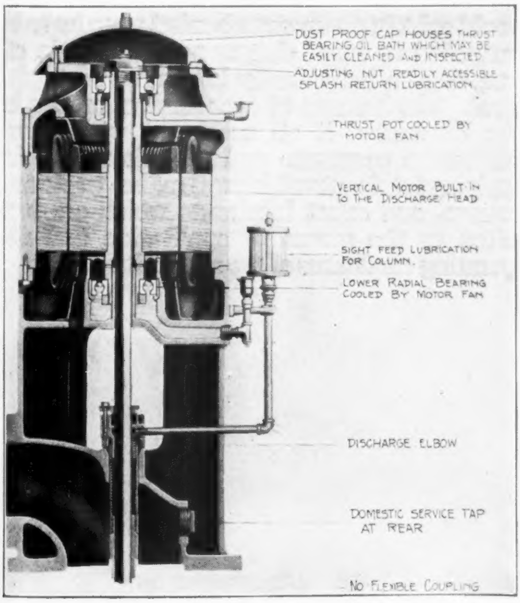
Whatever the type of lubricant, however, the design and location of the bearings is a most important feature. Usually they must be located relatively close together, on most pumps being about five feet apart. Where lubrication by means of fluid oil is practicable, it will usually be best to use a comparatively low viscosity product due to the high speeds involved. In general, a viscosity of from 100 to 200 seconds Saybolt at 100 degrees Fahr., will serve the purpose, providing that the stuffing box in the bottom of the cover pipe gives the requisite seal. An oil within this viscosity range would also be adaptable to lubrication of electric motor bearings. This would be an advantage, of course, for it would enable the use of one oil throughout the entire mechanism.

On the other hand, one must always consider the operating temperature range before making final decision as to the viscosity which will be most conducive to positive lubrication and minimum power consumption. This latter can be markedly affected by using too heavy an oil, as practical tests have indicated. The normal temperature of well water will be between 50 and 60 degrees Fahr.; seldom will it exceed 65 degrees Fahr., or be lower than 45 degrees Fahr. One should, therefore, study the viscosity of any lubricating oil intended for deep well pump lubrication at this operating range; obviously it will appear to be comparatively high. For example, an oil having an observed viscosity of 200 seconds Saybolt Universal at 100 degrees Fahr., will be between 1500 and 2000 seconds Saybolt at 45 degrees Fahr. It is evident that the use of too heavy an oil will involve considerable internal friction within the oil itself. Furthermore, if the oil is too heavy, it may not be able to pass through the bearing clearances fast enough to maintain proper lubrication. To some extent this would lead to increased temperature, which, of course, would tend to cause reduction in viscosity of the oil. On the other hand, there might also be an increase in power consumption which would be entirely unwarranted.

Under conditions of a marked difference in head, however, (especially where automatic circulation of the oil is not provided for) the oil might exert a pressure on the openings around the bottom bearings so much greater than would the water in the well (particularly when the pump is not operating) that this oil would run out at the bottom between the shaft and cover pipe, if the stuffing box happened to

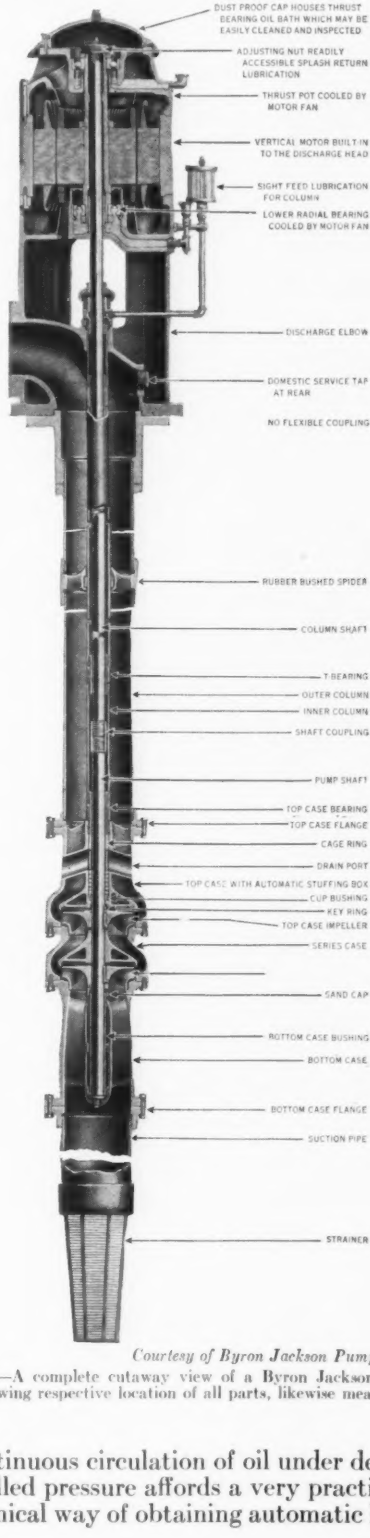
be worn to any extent. This occurrence will be indicated by excessive consumption of lubricant. On some types of pumps loss of oil can be prevented by controlling the rate of oil drip at the sight feed valves. On others it may be necessary to use a light grease which will be capable of giving adequate lubrication with as low a drag as possible and yet have sufficient body to resist the unbalanced pressure which may be involved. As wear on the stuffing box increases, it may be necessary to use a heavier grade of grease, though of course this may involve the sacrifice of a certain amount of mechanical efficiency. Such a grease should have a consistency very nearly the same as that of vaseline, and should be a product which will retain its plasticity at the approximate temperatures of pumping.

The adaptation of automatic balanced circulation lubrication, whereby oil is fed from a surface tank so located that oil and water pressures will be equalized is claimed to eliminate the possibility of waste and contamination of the well water. This oil is pumped through the bearings and back via a return pipe, by a suitable lubricant pump. Such a system makes possible the continued usage of a fluid lubricant capable of giving the desired results with the least development of internal friction. Of course it requires the use of a suitable cover pipe, within which the shaft and steady bearings are located. Here, the problem is much the same as involved with a turbine, excepting that the temperatures are lower. Therefore, oils of approximately the same viscosity as mentioned above should function satisfactorily.



Courtesy of Byron Jackson Pump Company.

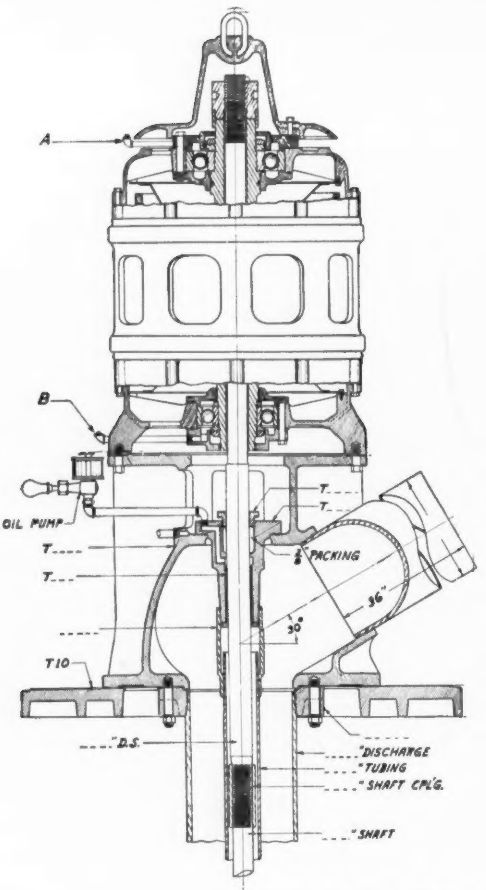
Fig. 17—Sectional elevation of the Byron Jackson built-in pump head motor arrangement. Note the application of ball bearings and the location of the means for lubrication.



Courtesy of Byron Jackson Pump Company.

Fig. 18—A complete cutaway view of a Byron Jackson deep well pump showing respective location of all parts, likewise means of lubrication.

Continuous circulation of oil under definitely controlled pressure affords a very practical and economical way of obtaining automatic lubrica-



Courtesy of Layne & Bowler, Inc.

Fig. 19—Section of a Layne Type TI-7 pump head showing oil pump for shaft bearings, and at A and B the lubricator extensions for serving the ball bearings of the electric motor.

tion with a minimum of labor and attention. As a rule, a considerably greater volume of oil will be handled in a circulating system than where a unit type lubricator is used. Direct pressure circulation of an excess of oil is admirable for lubricating bearings where suitable means is installed to completely control the path the oil follows. Lubrication by pressure circulation is also advantageous in that it provides for sufficient settling of the oil to insure precipitation of the greater part of any foreign matter that may have been picked up by the oil in passage through the bearings. Furthermore, since these are flood lubricated, they will be cooled as well as washed free from accumulations of foreign matter unless this latter is of a gummy nature resulting from the use of improperly refined oils. On the other hand, water cooling coils are sometimes installed to take away the heat acquired by the oil during circulation. By careful study of inlet and outlet temperatures of oil and water, and the use of coils of adequate capacity, accurate control of the inlet oil temperatures can be maintained.

The use of positive and automatic lubrication for deep well pumps will reduce the human factor in the maintenance of equipment, not only by virtue of the more positive degree with which lubricants are applied, but also by elimination of the apprehension which otherwise would exist in an operator's mind were he to be compelled to incur danger periodically in attempting to individually lubricate the equipment. The hazards of over-lubrication can be also eliminated if all concerned with pump lubrication cooperate and provide means for applying lubricants which will reduce waste and leakage, and select lubricants which are best suited to the means of application and the operating conditions of the respective pumps.

Printed in U. S. A. by
Edgar C. Ruwe Co., Inc.,
72 Washington St., N. Y. C.